Estimation of the Distributor/Wholesaler and Dealer/Contractor Markups on Incremental Central Air Conditioner and Heat Pump Costs

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1.0 Introduction

The markup on incremental cost increases is an important factor in estimating the price consumers pay for central air conditioners and heat pumps after a change in the minimum efficiency standard. For the central air conditioner and heat pump rulemaking, direct information on the *incremental* markup on equipment costs for higher efficiency units is not readily available. This is partially due to the fact that such units are often included in the construction costs of new housing or as a package that includes installation. In addition, because higher efficiency units may have different markups than baseline units at minimum efficiency and higher efficiency units are not produced at the same volume as baseline units, current incremental equipment costs observed in the market may not be representative of the incremental costs under a new standard.

In the analysis for the Supplemental Advance Notice of Proposed Rulemaking (SANOPR), manufacturer costs for the higher efficiency equipment under a new standard were estimated, and the consumer costs were obtained by applying markups at the different steps of the distribution chain to arrive at the final consumer cost. The distribution chain markup consists of a markup on incremental manufacturing costs applied by the manufacturers, a distributor/wholesaler markup applied by distributors and wholesalers, a dealer/contractor markup applied by dealers and HVAC contractors and a markup for sales tax. For the new housing market, a markup is also applied by housing developers and builders. The markups applied in the SANOPR analysis for distributor and dealer markups were determined from aggregate average markups for the businesses in the distribution chain. This means at each stage of distribution, direct costs of the sales were compared with the total volume of business, and the ratio of total business to direct costs was used to determine the markup on direct costs.

Numerous comments were received on the subject of markups at the wholesale and contractor level. Some comments received on the SANOPR analysis argued that markups on equipment prices should be fixed dollar markups rather than proportional as was assumed. Other comments suggested that the reasonable assumption is that standards will not cause a change in contractor profitability. The Department carefully considered these comments and concluded that the SANOPR markups at the distributor/wholesaler and dealer/contractor levels were excessive. The revised analysis examined the scaling behavior of markups for wholesalers and contractors, and determined that markups are neither fixed-dollar, nor proportional to all direct costs, but somewhere in-between. Using the available data, we have found measurable differences between *incremental* markups on direct equipment costs and the *average* aggregate markup on business direct costs. Significant differences were found between average and incremental markups

for heating, ventilation, air-conditioning and refrigeration (HVACR) wholesalers/distributors, and for HVAC dealers/contractors.

Table 1 provides a comparison of the markups that have been determined from the revised analysis and those which were used in the SANOPR.

Table 1 Comparison of Revised Markups and SANOPR Markups

Type	Revised Analysis Markup	SANOPR Markup
Manufacturer Markup	1.23	1.18
Wholesaler/Distributor Markups		
10 SEER	1.37	1.37
11 SEER	1.33	
12 SEER	1.30	
13 SEER	1.26	
18 SEER	1.21	
Dealer/Contractor		
Equipment Markup	1.27	1.55
Installation Labor		
Air Conditioners[a]	$1,279 / $1,367	$1,190
Heat Pumps[a]	$2,280 / $2,160	$2,035
Builder Markup	1.09[b]	1.00[c]
Sales Tax	1.04[b]	1.07[d]
Overall Markup		
10 SEER	2.42	2.68
11 SEER	2.36	2.68
12 SEER	2.30	2.68
13 SEER	2.24	2.68
18 SEER	2.14	2.68

[a] For revised analysis, first value pertains to split systems and second value pertains to single package systems.

[b] Weighted-average markups representing both the new construction and replacement markets.

[c] For the SANOPR, builder markups were not considered.

[d] For the SANOPR, sales taxes representing only the replacement market were used.

Table 2 shows the effect that the revisions have on the consumer's total installed price for split system air conditioners at efficiency levels ranging from 10 to 13 SEER.

Table 2 Total Installed Price Comparisons – Split Air Conditioners

Efficiency Level	Revised Analysis	SANOPR	Change
10 SEER	$2,236	$2,236	0%
11 SEER	$2,357	$2,403	-2%
12 SEER	$2,510	$2,613	-4%
13 SEER	$2,715	$2,895	-6%
18 SEER[a]	$3,302	$3,700	-11%

[a] Costs based on 15 SEER equipment.

The remaining sections of this report describe the methodology used to derive revised disaggregated and incremental markups at the distributor and dealer/contractor levels.

2.0 Comparison of SANOPR and Revised Markup Calculations

A key question in calculating the net impact of standard-induced price increases, is how these price increases are passed along to the consumer as the product proceeds through the distribution chain. The SANOPR analysis used an average aggregate markup for businesses in the distribution chain. In this revised markup analysis, we dis-aggregate the different component costs of business for distributors and dealers, and estimate how sales prices scale with equipment costs.

In the SANOPR analysis the markup on equipment was calculated from the gross margin for the industry as follows:

$$Markup\ factor = (1+b) = 1+\frac{m}{(1-m)} = \frac{1}{(1-m)}$$

where *(1+b)* is the markup factor and *m* is the gross margin which is the gross profit (*M*) divided by total revenues (P_{out}). Gross profit is defined as total revenues (P_{out}) minus direct costs. Direct costs are those costs that are attributed directly to the products and services being sold. Direct costs may include purchased equipment and materials (P_{in}) and billable labor (*W*). Note that the markup in the SANOPR analysis is mathematically equivalent to the following cost equation that relates business revenues to direct business costs:

$$P_{out} = P_{in} + W + M = (1+b)\cdot(P_{in} + W)$$

The assumption behind this equation is that the gross profit is directly proportional to the sum of direct costs. This assumption is only approximately true, and in the revised markup analysis we examine whether or not relaxing this assumption results in a significantly different markup. We then calculate a revised markup for equipment costs based on more general assumptions.

The main reason that the selling price of a product may not be strictly proportional to the purchase price of the equipment is that businesses incur a wide variety of costs. Therefore, when the purchase price of equipment and materials increases, only a fraction of the business expenses increase, while the remainder of the businesses' expenses stay relatively constant. For example if the unit price of an air conditioner increases by 30%, it is unlikely that the cost of secretarial support in an administrative office will increase by 30% also. Certain business expenses are relatively un-correlated with the cost of equipment or cost of goods.

We use two independent methods for determining which business expenses scale with the unit cost of equipment and materials. One method is an econometric statistical analysis of correlation between different business expenses (Section 3.0), and the other method is an analysis of the dis-aggregated business cost accounts (Section 4.0). These two independent methodologies yield approximately the same result for the estimated markup on incremental unit cost increases. Our analyses reproduce the results for the average direct cost markup factor as a special case when simplifying assumptions are made. But the analyses also show that the simplifying assumptions that lead to the SANOPR result do not explain the observed scaling of business costs seen in data from the U.S. Economic Census.

In our revised markup analysis, we calculated a slightly more complicated price model that allows one more degree of freedom than the SANOPR model. This extra degree of freedom allows part of the gross profit expenses to scale with labor or payroll expenses while the other part of the gross profit expenses scale with input materials and equipment costs. The price model in the revised analysis is:

$$P_{out} = (1+b)\cdot P_{in} + (1+c)\cdot W$$

Where P_{in} is the input materials and equipment costs, and W is a labor cost, either total payroll or billable contractor labor. The SANOPR model is a special case of the revised analysis where either $W = 0$, or $(1+b) = (1+c)$, for distributor markups and dealer markups, respectively.

In the econometric approach, we take U.S. Economic Census data from 1997 (refer to Appendices C and D) and test which model better explains state-by-state revenue data for the industry, and if differences between the parameters found in the revised analysis and the SANOPR analysis are statistically significant. We find that the differences between the SANOPR assumptions and the revised model are statistically significant according the regression analyses. We also computed the markup factors for the new price model and the confidence intervals for the markup factors.

For the expense accounting approach we analyze the dis-aggregated breakdown of business expenses as provided in reports by the relevant business association (refer to Appendices A and B). Those expenses that are payroll, labor, or occupancy, are assumed to scale with labor expenses, while all other expenses are assumed to scale with aggregate direct costs. Both approaches yield approximately the same result.

We also performed several sensitivity tests on our calculations. These sensitivities included adding an extra parameter in our cost equation to calculate marginal markup factors. For the contractor industry, we also tested the scaling of gross profit vs. direct labor (installation labor for dealers) and total payroll.

3.0 Econometric Analysis of U.S. Census Data

Distributor Markups

The economic data of revenues and costs for warm air heating and air conditioning equipment and supplies wholesalers are provided by the U.S. Census Bureau, 1997 Economic Census (refer to Appendix D).[1] Forty-one states from the U.S. Census data give the value of the total sales, the payroll amounts, and the operating expenses (the states of Alaska, Kansas, Maine, Massachusetts, New Hampshire, Rhode Island, South Dakota, Vermont, and Wyoming and the District of Columbia did not provide the necessary data). Given an estimate of the operating profit (defined as total sales minus the cost of goods sold and all operating expenses), a value for the gross profit (defined as total sales minus the cost of goods sold) can be calculated state-by-state. Then, using the variability in the relative size of costs of goods and payroll state-to-state, we develop a regression between the cost of goods, payroll and the gross margin per firm.

To provide a reasonably accurate estimate of the state-by-state average operating profit per firm, we examined cross-industry wholesale operating profits from the 1992 U.S. Census.[2] This data shows an average of 5.5% operating profit and a standard deviation of about 2.5%. (Note: In the 1992 U.S. Census data, operating profit is termed gross profit.) We decided to examine a range of operating profit values to provide a sensitivity check on our average operating profit assumptions. We used a 3% operating profit as the low end, the 5.5% operating profit assumption as the median and an 8% operating profit assumption as the high end. The average operating profit for the air conditioning wholesale industry in 1992 was 5.5%.

The table in Appendix D shows the state-by-state wholesale business data that is used to dis-aggregate the different components of the wholesale gross margin. Using Microsoft Excel's regression tool we calculate b and $1+c$ in the following equation

$$M/P_{out} = b \cdot P_{in}/P_{out} + (1+c) \cdot W/P_{out}$$

where M is the gross profit (P_{out} - P_{in}), $1+b$ is the markup on equipment expenses, P_{in} is the equipment expense, $1+c$ is the scaling factor for payroll-related expenses, and W is the payroll of the wholesale business.

From the two-dimensional regression we have the following table (Table 3), where the Min values represent the low end of the 95% confidence interval and the Max value represents the high end of the 95% confidence interval.

Table 3 Distributor Markups derived from Census Data

	Equipment Markup Factor (1+b)			Labor Markup Factor (1+c)		
Operating Profit Assumption	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**
3% of Total Sales	1.02	1.06	1.12	1.29	1.66	2.04
5.5% of Total Sales	1.04	1.09	1.14	1.33	1.71	2.09
8% of Total Sales	1.06	1.12	1.18	1.37	1.76	2.15

This analysis supports a scenario where the markup on incremental equipment costs are significantly lower than the average markup of 1.37 that was used in the SANOPR analysis. We select 1.09 as a markup value that is large enough to preserve a substantial operating profit for the wholesale industry.

One question about the methodology applied to the state-by-state data is that the method assumed no correlation between operating expense fraction and operating profit. A 1998 wholesaler profit survey report provided by the Air-conditioning & Refrigeration Wholesalers Association (ARW) has data that indicates there in fact may be an anti-correlation between the gross margin and operating profit.[3] The question is what may be the sensitivity of the gross margin calculation to such correlation effects. By examining page 13 in the ARW report, we find that the operating profit increases from 1.4% to 2.7% when the total operating expenses decreases from 28.4% to 22.1%. We can use the relationship of a 1% operating profit change per 6% operating expense change to provide an anti-correlation relationship between operating profit and operating expenses. When we assume a 1% per 6% anti-correlation and recalculate the markup factor for cost of goods using this assumed relation, we obtain a new markup factor of 1.13 with a 95% confidence interval for the regression ranging from 1.08 to 1.17. To do the calculation, we calculated the deviation of the fractional operating cost from the mean, and then assumed a 1% change in fractional operating profit for each 6% change in fractional operating cost.

Dealer Markups

For the dealer markups a very similar approach was taken. State-by-state data on the HVAC contractor industry was obtained from the 1997 Economic Census (refer to Appendix C).[4] We then took the fractional gross margin and examined the two-parameter correlation between the fractional materials cost and factional wage expenses. We did two fits, one looked at only construction wages as an explanatory variable, while the other looked at total payroll (similar to the analysis for the wholesale industry). Results are summarized in Table 4. We find that when we separate the portions of the gross markup according to materials and construction labor, that the mean markup factor for the materials portion is 1.27. We also find that if we assume that administrative and non-production labor expenses to be constant, then the mean markup on materials and equipment expenses is 1.15. A mathematically equivalent regression can be done

by simply correlating the net value of construction per firm against materials expenses and the relevant payroll expense.

Table 4 Contractor Markups derived from Census Data

	Equipment Markup Factor			Labor Markup Factor		
Analysis Method	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**
2D Regression: W=construction worker wages	1.09	1.27	1.45	1.66	1.99	2.33
2D Regression: W=all employees payroll	0.99	1.15	1.31	1.38	1.58	1.79

Note that when we use this state-by-state data to calculate the following model:

$$M/P_{out} = b \cdot \left(P_{in}/P_{out} + W/P_{out} \right)$$

We obtain an average markup factor of 1.52, which agrees closely with the markup used in the SANOPR analysis. Our approach therefore starts with a price model consistent with the SANOPR analysis, and then removes some of the assumptions that restrict the description of the scaling behavior of the gross margin. When the assumption of equality between equipment and labor cost markups is removed, we find a significant difference between the two markup factors. The statistical confidence tests done with the slightly less restrictive model show that the assumptions behind the presumed mathematical restrictions in the SANOPR analysis are not supported by the U.S. Economic Census data.

4.0 Analysis of Industry Cost Accounts

Distributors

Appendix B shows the detailed cost breakdown for an average air-conditioning wholesale business. The cost data is provided by the *1998 Wholesaler Profit Survey Report* published by the Air-conditioning & Refrigeration Wholesalers (ARW).[5] This report shows (on page 23) that 14.6% of sales revenues is spent on recovering payroll expenses, that 3.6% is spend on recovering occupancy expenses, that 8.1% of sales revenues goes to other operating expenses and operating profit which we might expect to scale with the unit price of equipment. Since the costs of sales is 73.6% of total sales revenues, this indicates that the markup incremental equipment costs should be about 1+8.1%/73.6% = 1.11, a figure that is in agreement with the results obtained from the correlation analysis.

Dealers/Contractors

We check the consistency of the markups derived from the correlation analysis of the 1997 U.S. Economic Census data with the data that is provided in the 1995 edition of *Financial Analysis for the HVACR Contracting Industry* published by the Air Conditioning Contractors of America.[6] To do this we examine the detailed cost breakdown, or dis-aggregation of the different components of the gross margin expenses. The data for the cost breakdown is provided in Appendix A of this report.

In this cost disaggregation we select those costs that would scale with wage rates and those costs that would tend to scale with all direct costs. This is a method for assigning the gross margin expenses between those costs that would scale with equipment and miscellaneous expenses, and those gross margin costs that would tend to scale with direct labor costs. For example in state-by-state comparisons wage rates in different states may vary considerably. The hypothesis of this analysis approach is that those components of the gross margin that are related to wages will tend to correlate with the wage portion of the direct costs. If we do this assignment, then we find that 16.43% of total costs are part of the gross margin and would scale with wages, while about 18.4% of total costs are part of the gross margin and may scale with all direct costs. This implies that the markup factor for non-wage direct costs would be 1 +18.4%/65.4% = 1.28. Similarly, the markup factor for direct labor costs should be 1 + 0.28 + 16.4%/19% = 2.15.

5.0 Average, Disaggregated, and Marginal Markups

In this section we discuss the difference between average, disaggregated, and marginal markups. Different markups arise as they are averaged over different categories of costs, or as they are averaged over different scales of cost.

For example, in the SANOPR analysis, the contractor markup is the average markup for all direct costs. The direct costs include both direct labor and materials and equipment. If we then divide the direct costs into different categories and calculate separate markups on the different categories of direct costs, then we are calculating disaggregated markups. Disaggregated markups can still be average and marginal, but they are broken down into different categories of costs and are thus "disaggregated."

Marginal markups are the markups that are applied to costs at the margin. That means for an incremental cost increase, it is the markup factor that is applied to the incremental cost increase to get the incremental price increase. A marginal price increase may be obtained by taking cost and price data and fitting a line for the cost/price relationship. The slope of the price vs. cost line gives the marginal markup. Figure 1 illustrates the concept of prices at the margin. Two cases are presented in Figure 1: one where the price vs. cost relationship has a fixed portion which does not vary with cost and another where the marginal price equals the average price. In the first case, the price being charged has a fixed portion which is related to other expenses not pertaining to the cost of equipment. In the second case, if the cost to the distributor or

dealer is zero, than the price charged is also zero, which illustrates that when the fitted line has an intercept of zero, price is strictly proportional to cost and the marginal price equals the average price.

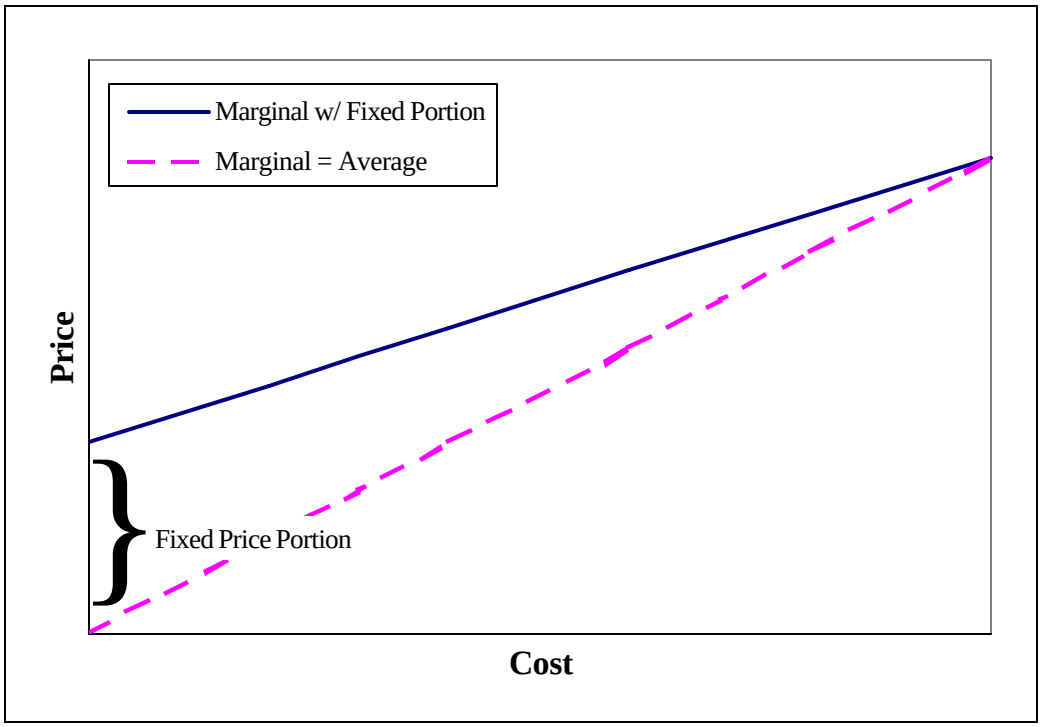

Figure 1 Cost/Price Relationship illustrating Prices at the Margin

Figure 2 illustrates for wholesalers/distributors the concept of average, disaggregated, and marginal markups. At the baseline efficiency level (i.e., 10 SEER), the average markup covering both equipment and labor expenses is 1.37. As indicated in the analyses described previously, the marginal markup associated with the incremental change in equipment and materials cost is approximately 1.09. In our analyses, we have found that the marginal markup for equipment and materials is not significantly different from the average disaggregated equipment markup. For efficiency levels beyond the baseline, the markup on equipment is then essentially composed of two portions; the average markup that is applied to the "base" portion (i.e., that portion associated with covering expenses of the baseline equipment) and the marginal markup that is applied to the incremental change in equipment cost. As a result of applying different markups to the "base" and "incremental" portions of the equipment cost, the aggregate markup decreases slightly with increasing efficiency. In the case of split system air conditioners, the aggregate markups are 1.33 at 11 SEER, 1.30 at 12 SEER, and 1.26 at 13 SEER.

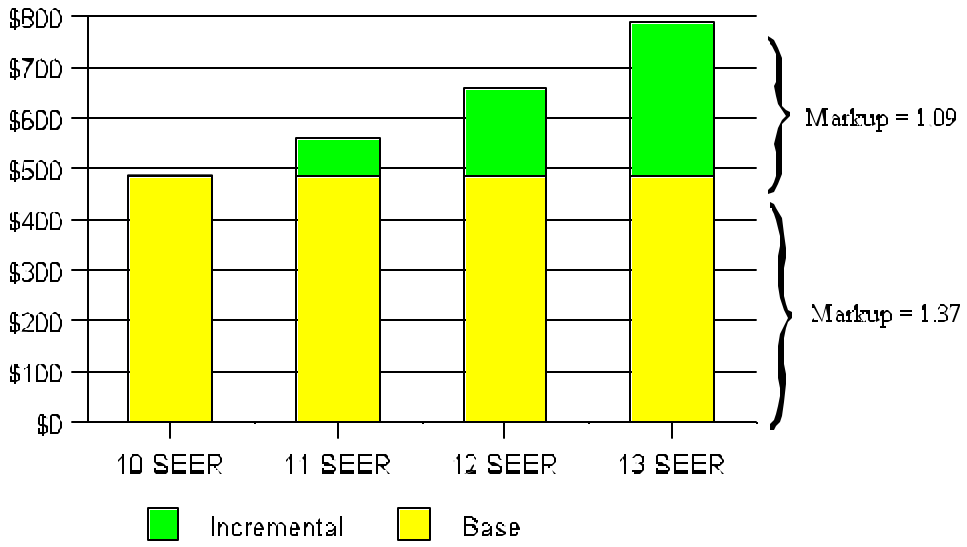

Figure 2 Base and Incremental Costs and Markups for Split System Air Conditioners at the Wholesaler Level

6.0 Sensitivity Test of Marginal Markup Measurements

As a further sensitivity test for our dis-aggregated markup numbers, we re-calculate the materials and equipment markups using a three parameter model that allows the marginal markup on equipment to be different than the average dis-aggregated markup on materials. In this slightly more complicated model the output cost of materials is a three-parameter linear function of equipment and labor costs, specifically:

$$P_{out} = (1+b)\cdot P_{in} + (1+c)\cdot W + a$$
$$M = b\cdot P_{in} + c\cdot W + a$$

In this revenue model P_{in} is the per-firm annual cost of materials and equipment, $(1+b)$ is the marginal markup factor on materials and equipment, M is the gross profit, and P_{out} is the total per firm revenues. Also, W is either the total payroll (for wholesale business) or the payroll of construction worker labor.

When we calculate the parameters for this three-parameter per-firm revenue model using state-by-state averages from Census data we obtain:

Table 5 Contractor and Distributor Marginal Markups derived from Census Data

	Equipment Markup			Labor Markup			Constant ($1000/firm)		
Industry Type	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**
Contractor	0.97	1.17	1.37	1.71	2.02	2.32	-3	31	65
Distributor	1.04	1.09	1.14	1.08	1.54	2.00	-41	60	160

These results show that the constant term in the per-firm revenue model is statistically close to zero (i.e. zero is included in the 95% confidence interval for the constant). Also, the marginal equipment markup factors for the marginal markup analysis substantially overlap with the markup factors for the average dis-aggregated markups obtained from the two-parameter price model.

7.0 Summary of Results

Table 6 summarizes the results from our analyses. We find that there is a range of possible markup values that are obtained, but that the mean recomputed markup factors range from 1.06 to 1.13 for the distributor markup on equipment price and from 1.15 to 1.28 for the contractor equipment markup.

Table 6 Price Markup Comparisons

Analysis Method	**Equipment Markup**	**Wage Markup**
Dealer Markups		
Correlation Analysis: installation labor constant	1.27	1.99
Correlation Analysis: all labor constant	1.15	1.58
Correlation Analysis: marginal markup (equip. & install. labor)	1.17	2.01
ACCA Data Analysis allocating Gross Margin Payroll expenses to install labor	1.28	2.15
Distributor Markups		
Correlation Analysis: operating profit fixed @ 3%	1.06	1.66
Correlation Analysis: operating profit fixed @ 5.5%	1.09	1.71
Correlation Analysis: operating profit fixed @ 8%	1.12	1.76
Correlation Analysis: operating profit and operating expenses anti-correlated	1.13	1.45
Correlation Analysis: marginal markup	1.09	2.00
ARW Data Analysis	1.11	-

For the dealer markups, three correlation analyses were performed: The first analysis divides the costs into one component that scales with direct labor (i.e. installation labor) and another that scales with equipment costs. The second analysis divides costs into a component that scales with equipment and another part that scales with total payroll. And the third analysis allows firms to have one cost component that scales with neither installation labor nor equipment, one component that scales with installation labor, and a third

component that scales with equipment. We refer to the third approach as a marginal markup calculation (because is calculates the markup scaling at the margin, for incremental changes in firm expenses).

In addition we calculate the markup from a dis-aggregated accounting of dealer costs obtained from the *Financial Analysis For The HVACR Contracting Industry* (refer to Appendix A).

For distributor markups, five correlation analyses are performed. The first four analyses test different sensitivities regarding our assumption about operating profits. The available data did not directly report cost of goods, so the cost of goods was calculated using different assumptions about the operating profit (total sales minus all costs). The first three analyses assumed that the operating profit is a fixed amount of total sales, while the fourth analysis assumed that there exists an anti-correlation between operating profit and operating expenses. The fifth correlation analysis examines marginal markups (with a fixed 5.5% operating profit assumption) where a component of per-firm business expenses is allowed to scale with neither payroll nor cost of goods.

In addition we calculate the markup from a dis-aggregated accounting of distributor costs obtained from the *1998 Wholesaler PROFIT Survey Report* by the Air-conditioning & Refrigeration Wholesalers Association (ARW) (refer to Appendix B). This results in an estimate of 1.11 for the distributor markup.

In addition to summarizing the result in the previous table we plot the different methodologies, their answers and the approximate error bars (95% confidence interval) for the different markup analysis methods and assumptions.

Figure 3 shows the results for the distributor markup calculations.

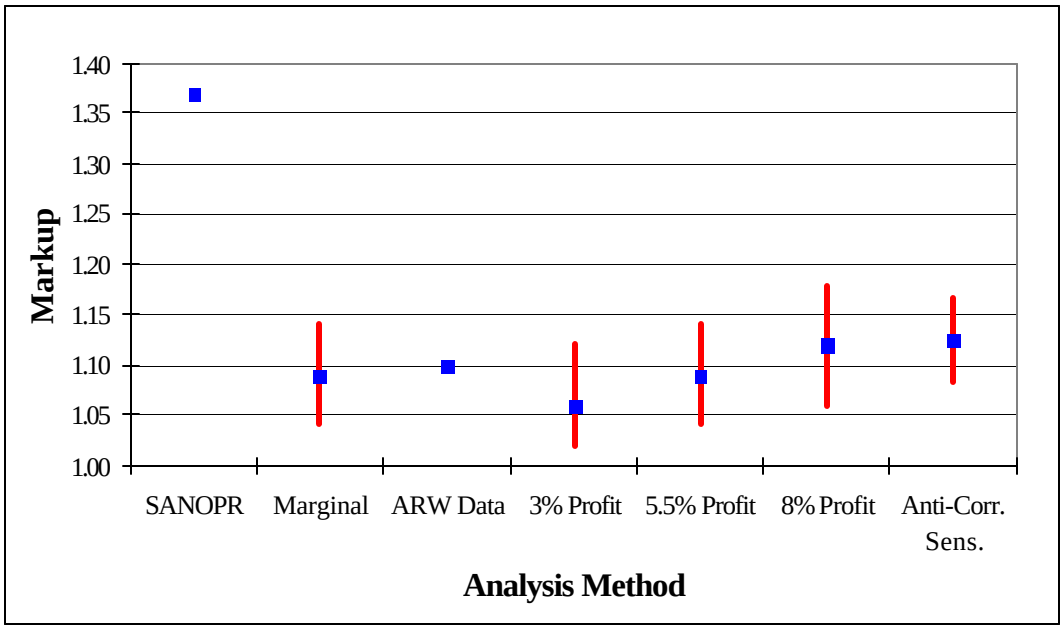

Figure 3 Comparison of Wholesaler/Distributor Markups

We see from the 'Wholesale Equipment Markups' figure that once we depart from the average markup assumption, different methods produce values between 1.02 to 1.18. We select a value of 1.09 for the distributor markup on incremental costs. This represents the mean value we obtain when mean operating profits are at the average (at about 5.5%).

Contractor markups on equipment calculated from different approaches are shown in Figure 4. Most methods provide results that are significantly lower than the 1.55 average markup used in the SANOPR analysis. We adopt the analysis with the constant install labor as a reasonable approach consistent with our analysis of the ACCA dis-aggregated accounting of gross margin expenses.

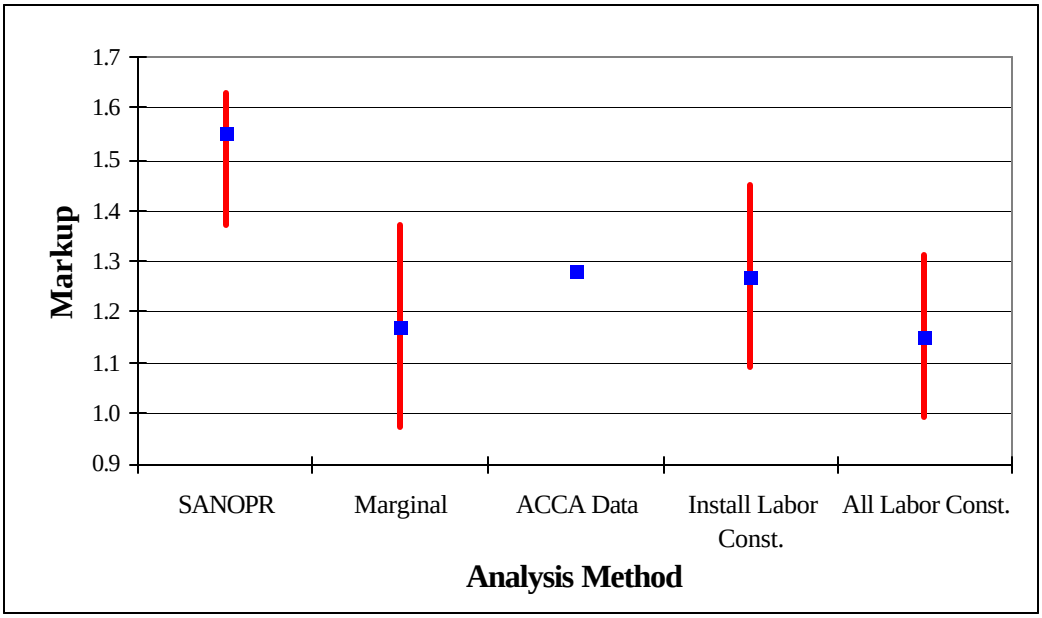

Figure 4 Comparison of Dealer/Contractor Markups

8.0 Conclusion

Responding to comments the Department received on the markups used in the SANOPR analysis, we performed preliminary, yet comprehensive, statistical analysis of the markups on incremental equipment costs for distributors and dealers of air conditioners and heat pumps. There is very strong evidence that the average aggregate markups used in the SANOPR analysis over-estimated the markups on incremental equipment costs. We performed a variety of statistical analyses for the incremental cost markups using both dis-aggregated two-parameter price models, three parameter marginal markup models, and analysis of dis-aggregated cost accounts for distributor and dealer businesses. All approaches in the revised analysis produce consistent results given the computed statistical confidence ranges of the analyses. Given the

weight of evidence and the range of results, we select **1.09** as a reasonable estimate of the distributor markup on incremental costs and will continue to use **1.37** as the distributor markup on the base portion of equipment cost. For the dealer, we select **1.27** as a good estimate for the dealer markup on both the incremental and base portions of equipment costs, and we raise the installation labor price to compensate for the drop in average equipment markup.

Appendix A: Disaggregated Costs for HVACR Contractors

From the 1995 edition of *Financial Analysis for the HVACR Contracting Industry* published by the Air Conditioning Contractors of America (ACCA).

Table A.1 Cost Disaggregation for Contractors

Item	Fraction	Scaling
Direct Materials	22.70%	
Equipment Installed	14.22%	
Direct Labor	19.01%	
Direct Subcontract	5.55%	
Direct Other	3.97%	
Total Cost of Sales	**65.45%**	
Gross Margin	**34.55%**	
Operating Expenses		
Advertising	1.10%	All Costs
Bad Debts	0.16%	All Costs
Depreciation	1.02%	All Costs
Interest Expenses	0.33%	All Costs
Liability Insurance	1.12%	All Costs
Other Insurance	1.36%	All Costs
Occupancy Costs	1.24%	Labor
Payroll Taxes/Fringe Benefits	4.02%	Labor
Selling Expense	1.49%	All Costs
Officer Salaries	3.80%	Labor
Sales and Estimating Salaries	2.69%	Labor
Administration Salaries	3.18%	Labor
Warehouse Salaries	0.46%	Labor
Unapplied Labor	1.04%	Labor
Vehicle/Maintenance Repairs	1.82%	All Costs
Other Operating Expenses	5.13%	All Costs
Total Operating Expenses	**29.96%**	
Net Operating Profit	4.59%	All Costs
Other Income	0.79%	All Costs
Other Expenses	-0.49%	All Costs
Net Profit Before Income Taxes	**4.89%**	
Gross Margin Scaling with all Costs	**18.42%**	
Gross Margin Scaling with Labor Only	**16.43%**	
Average Markup Factor	**1.53**	
Markup Factor for Non-Labor Costs	**1.28**	
Markup Factor for Labor Costs	**2.15**	

Appendix B: Disaggregated Costs for ARW Wholesalers/Distributors

Taken from the *1998 Wholesaler Profit Survey Report* published by the Air-conditioning & Refrigeration Wholesalers Association ARW). Note that some figures may not add up due to rounding.

Table B.1 Disaggregated Costs for ARW Wholesalers/Distributors

Item	Fraction	Scaling
Cost of Goods Sold	**73.6%**	
Gross Margin	**26.4%**	
Payroll Expenses		
Executive Salaries & Bonuses	2.7%	Labor
Inside Sales Salaries/Wages	3.2%	Labor
Outside Sales Salaries/Commissions	2.2%	Labor
Warehouse & Delivery Salaries/Wages	2.3%	Labor
All Other Salaries/Wages & Bonuses	2.1%	Labor
Payroll Taxes	1.1%	Labor
Group Insurance	0.7%	Labor
Benefit Plans	0.5%	Labor
Total Payroll Expenses	**14.6%**	
Occupancy Expenses		
Utilities: Heat, Light, Power, Water	0.4%	Labor
Telephone	0.6%	Labor
Building Repairs & Maintenance	0.2%	Labor
Rent or Ownership in Real Estate	2.4%	Labor
Total Occupancy Expenses	**3.6%**	
Other Operating Expenses		
Advertising and Promotion	0.9%	All Costs
Insurance	0.4%	All Costs
Depreciation	0.7%	All Costs
Bad Debt Losses	0.3%	All Costs
All Other Operating Expenses	3.2%	All Costs
Total Other Operating Expenses	**5.4%**	
Operating Profit	**2.7%**	All Costs
Gross Margin Scaling with All Costs	**8.2%**	
Gross Margin Scaling with Labor Only	**18.4%**	
Average Markup Factor	**1.36**	
Markup Factor for Non-Labor Costs	**1.11**	

Appendix C: U.S. Census Data for HVAC Contractors

Data from U.S. Census Bureau, 1997 Economic Census, *Plumbing, Heating, & Air-Conditioning Contractors* (NAICS code: 235110, SIC code: 171100). All monetary values are in dollars per firm. The *Number of Firms* are provided in Table 11 of the Census Report (column B (*establishments located in the state*) plus column F (*establishments not reporting*)). The *Net Value* and *Materials* are provided in Table 3 of the Census Report, columns B and D, respectively. The *Construction Payroll* and *Total Payroll* are provided in Table 2 of the Census Report, columns I and H, respectively.

Table C.1 U.S. Census Data for HVAC Contractors

State	Number of firms	Net Value per firm	Materials per firm	Construction Payroll per firm	Total Payroll per firm
Alabama	1413	$817,573	$332,335	$185,157	$265,764
Alaska	187	$878,198	$332,160	$208,893	$296,770
Arizona	1344	$1,081,209	$498,973	$234,172	$330,664
Arkansas	980	$559,841	$238,308	$125,924	$172,609
California	6776	$1,096,027	$453,715	$270,016	$369,007
Colorado	1654	$925,321	$411,807	$217,824	$301,684
Connecticut	1254	$727,402	$290,203	$168,619	$242,767
Delaware	288	$1,308,066	$477,521	$338,219	$484,049
Florida	4803	$808,400	$362,941	$168,369	$251,964
Georgia	2589	$958,351	$412,534	$196,896	$287,993
Hawaii	243	$950,984	$347,305	$221,103	$324,564
Idaho	546	$847,046	$371,817	$182,502	$246,954
Illinois	3756	$1,130,302	$429,262	$295,798	$398,058
Indiana	1973	$1,098,435	$446,279	$279,622	$382,440
Iowa	938	$908,019	$355,371	$214,907	$293,711
Kansas	1065	$847,007	$388,001	$187,319	$259,248
Kentucky	1178	$847,152	$356,896	$197,961	$269,195
Louisiana	1200	$757,721	$325,003	$157,684	$231,641
Maine	552	$451,821	$198,065	$99,317	$142,630
Maryland	2037	$1,116,541	$489,080	$254,578	$374,130
Massachusetts	2172	$848,455	$363,227	$186,431	$267,121
Michigan	3187	$928,415	$366,709	$221,138	$307,104
Minnesota	1416	$1,100,958	$455,536	$265,766	$369,213
Mississippi	746	$702,544	$330,367	$139,425	$195,009
Missouri	1824	$892,012	$345,791	$225,493	$312,252
Montana	412	$553,058	$269,126	$124,284	$165,854
North Dakota	248	$827,331	$340,887	$210,633	$272,327
North Carolina	3057	$899,984	$387,419	$198,937	$286,183
Nebraska	662	$801,965	$344,559	$190,705	$264,314
Nevada	515	$1,575,707	$691,083	$378,497	$496,474
New Hampshire	462	$691,561	$303,656	$148,652	$207,582
New Jersey	3320	$741,231	$299,900	$174,226	$247,283
New Mexico	600	$596,717	$259,115	$156,492	$206,905
New York	5234	$884,105	$360,541	$193,445	$291,500
Ohio	3329	$1,010,347	$405,283	$252,854	$347,859
Oklahoma	1156	$586,724	$252,590	$116,183	$161,541
Oregon	1079	$1,112,995	$461,787	$308,114	$407,706
Pennsylvania	3546	$1,006,816	$418,842	$234,297	$329,217
Rhode Island	356	$573,893	$256,272	$123,124	$176,003
S Dakota	311	$502,113	$230,621	$109,987	$160,559
South Carolina	1351	$799,229	$358,672	$194,019	$265,561
Tennessee	1612	$1,087,848	$506,068	$235,924	$352,965
Texas	5516	$982,148	$449,987	$207,952	$298,124
Utah	835	$939,435	$375,856	$207,865	$280,911
Virginia	2391	$822,614	$361,340	$198,761	$281,273
Vermont	245	$563,273	$224,543	$137,878	$184,453
Washington	1746	$1,008,192	$397,266	$239,093	$340,587
West Virginia	496	$589,083	$279,732	$133,143	$169,135
Wisconsin	1981	$979,285	$373,594	$258,869	$352,044
Wyoming	264	$445,027	$199,686	$98,580	$148,114

Appendix D: U.S. Census Data for Air Conditioning Wholesalers/Distributors

Data from U.S. Census Bureau, 1997 Economic Census, *Wholesale Trade, Geographic Area Series* (NAICS code 42173). All values in the table below are taken from Table 1 of the Census report. Operating profit numbers are calculated with fixed percentage profit assumption.

Table D.1 U.S. Census Data for Air-Conditioning Wholesalers/Distributors

	Number of	**Total Sales**	**Payroll**	**Operating Exp.**	**Operating Profit** (*thousands*)		
State	**firms**	*thousands*	*thousands*	*thousands*	3%	5.5%	8%
Alabama	123	$334,554	$27,473	$54,156	$10,037	$18,400	$26,764
Connecticut	58	$204,159	$28,127	$46,483	$6,125	$11,229	$16,333
Florida	445	$1,226,541	$130,367	$244,635	$36,796	$67,460	$98,123
Idaho	31	$64,013	$6,201	$12,317	$1,920	$3,521	$5,121
California	374	$1,418,645	$148,279	$273,028	$42,559	$78,025	$113,492
Louisiana	123	$187,972	$29,924	$59,059	$5,639	$10,338	$15,038
Maryland	114	$469,325	$43,287	$79,097	$14,080	$25,813	$37,546
Michigan	188	$640,856	$69,630	$131,499	$19,226	$35,247	$51,268
New Jersey	181	$586,349	$77,995	$143,024	$17,590	$32,249	$46,908
New York	270	$918,325	$111,921	$206,395	$27,550	$50,508	$73,466
Oregon	54	$366,449	$25,083	$44,120	$10,993	$20,155	$29,316
Texas	521	$2,722,527	$209,839	$592,747	$81,676	$149,739	$217,802
Wisconsin	106	$357,000	$45,111	$73,302	$10,710	$19,635	$28,560
Arizona	81	$361,629	$38,771	$63,032	$10,849	$19,890	$28,930
Colorado	76	$234,628	$28,625	$51,912	$7,039	$12,905	$18,770
Indiana	139	$510,718	$51,994	$96,568	$15,322	$28,089	$40,857
Missouri	135	$806,101	$51,976	$96,259	$24,183	$44,336	$64,488
Nebraska	44	$113,047	$11,603	$23,195	$3,391	$6,218	$9,044
South Carolina	111	$318,191	$28,280	$50,262	$9,546	$17,501	$25,455
North Dakota	6	$5,625	$736	$994	$169	$309	$450
Tennessee	150	$821,211	$72,885	$124,843	$24,636	$45,167	$65,697
Washington	105	$361,962	$41,547	$76,915	$10,859	$19,908	$28,957
Minnesota	75	$349,361	$40,805	$69,926	$10,481	$19,215	$27,949
Kentucky	99	$411,191	$35,996	$72,273	$12,336	$22,616	$32,895
Arkansas	56	$121,159	$12,112	$26,020	$3,635	$6,664	$9,693
Delaware	25	$61,435	$6,278	$10,077	$1,843	$3,379	$4,915
Georgia	206	$724,408	$68,794	$129,235	$21,732	$39,842	$57,953
Hawaii	13	$35,290	$3,595	$7,848	$1,059	$1,941	$2,823
Illinois	237	$902,720	$86,711	$181,192	$27,082	$49,650	$72,218
Iowa	41	$59,672	$7,486	$14,234	$1,790	$3,282	$4,774
Mississippi	49	$101,853	$8,672	$18,449	$3,056	$5,602	$8,148
Montana	16	$28,924	$3,688	$6,719	$868	$1,591	$2,314
Nevada	39	$149,749	$12,654	$23,734	$4,492	$8,236	$11,980
New Mexico	23	$65,773	$6,558	$14,473	$1,973	$3,618	$5,262
North Carolina	226	$762,218	$77,307	$142,805	$22,867	$41,922	$60,977
Ohio	236	$845,271	$94,170	$171,236	$25,358	$46,490	$67,622
Oklahoma	89	$221,039	$19,873	$37,626	$6,631	$12,157	$17,683
Pennsylvania	235	$756,528	$86,397	$89,554	$22,696	$41,609	$60,522
Utah	38	$138,458	$14,866	$24,734	$4,154	$7,615	$11,077
Virginia	141	$533,211	$52,658	$101,976	$15,996	$29,327	$42,657
West Virginia	106	$81,211	$6,656	$13,503	$2,436	$4,467	$6,497

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